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Utility Emissions Software for the NAPAP
(National Acid Precipitation Assessment Program)
1985 Emissions Inventory

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Utility Emissions Software for the
NAPAP 1985 Emissions Inventory

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16. ABSTRACT The paper discusses utility emissions software for the development of the National Acid Precipitation Assessment Program (NAPAP) 1985 emissions inventory. For 1985, the development of an accurate and complete emissions inventory for pollutants considered to be precursors of acid deposition was identified as a critical element of the NAPAP. For 1985, NAPAP high priority emissions inventory data needs were incorporated into the National Emissions Data System (NEDS) reporting process with the primary objective being to complete a national source/emissions data base for calendar 1985 for all sources with actual emissions of NO ₂ , NO _x , or VOCs greater than 100 tons per year. Recognizing the importance of electric utilities as a component of the NAPAP 1985 emissions inventory, and to assist the states in preparing their 1985 NEDS submittals, the project described in this paper made some of the utility data submitted to the U.S. Department of Energy (DOE) available on microcomputers so that they could be used readily by state air pollution control agencies and others. These data are submitted to DOE annually on Form EIA-767, the steam-electric plant operation and design report. The microcomputer software developed enables state agencies to access Form 767 data without having to refer constantly to hard copy forms.		11. CONTRACT/GRANT NO. 68-02-4070, Tasks 19, 20	
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INTRODUCTION

For calendar year 1985, the development of an accurate and complete emissions inventory for pollutants considered to be precursors of acid deposition was identified as a critical element of the National Acid Precipitation Assessment Program (NAPAP). For 1985, NAPAP high priority emissions inventory data needs were incorporated into the National Emissions Data System (NEDS) reporting process with the primary objective of completing a national source/emissions data base for calendar year 1985 for all sources with actual emissions of sulfur dioxide (SO_2), nitrogen oxides (NO_x), or volatile organic compounds (VOC) greater than 100 tons (90.7 megagrams) per year. Recognizing the importance of electric utilities as a component of the NAPAP 1985 Emissions Inventory, and to assist the states in preparing their 1985 NEDS submittals, the project described in this paper made some of the utility data submitted to the U.S. Department of Energy (DOE) available on microcomputers so that they could be readily used by state air pollution control agencies and others.

Because there have been frequent discrepancies between utility data submitted to DOE and to NEDS in the past, it was thought that it would be to the states' advantage to have DOE data available to them at the time they were preparing their 1985 NEDS submittals. Thus, state air pollution control agencies were provided with both microcomputer software and hard copy printouts of DOE data that could be compared with data provided to state agencies by the utilities on their own questionnaires.

The microcomputer software portion of this study may serve as a pilot project for further routine data distribution of utility data to state air pollution control agencies. Thus, user comments on the usefulness of the software and DOE data are encouraged.

This paper focuses on the microcomputer software developed to enable state air pollution control agencies direct access to utility data submitted to DOE. The data thus made available in automated form are submitted to DOE annually on Form EIA-767, the steam-electric plant operation and design report. This form is completed by each U.S. plant with a total existing or planned organic- or nuclear-fueled steam electric generator nameplate rating of 100 MW or greater. The form is designed for reporting at two levels: the plant level and the equipment level (i.e., generator, boiler, or flue gas collector).

The objective in providing software for accessing automated Form EIA-767 utility data was to enable state air pollution control agencies to develop utility emissions inventories that are as up-to-date as possible. The software enables state agencies to access Form EIA-767 data, without having to constantly refer to hard copy forms. The 1982 Form EIA-767

automated file was used in developing the software, but later years of data can be manipulated using the same software.

Data for 1982 were used because the 1982 Form EIA-767 submissions represent the most current automated file. Thus, the product of the project described here was a prototype system that provides state air pollution control agencies with an opportunity to review and perhaps utilize data that otherwise might not be available. With the emphasis on quality assurance in the 1985 NAPAP Emissions Inventory process, access to the Form EIA-767 data gave the states a preview of the data that would eventually be used as a quality control check on the data they submitted to NEDS.

The information provided to the state agencies, in the data base delivered as part of this project, was a subset of the DOE automated file of Form EIA-767 data. Data elements were selected from the file that were thought to be of most relevance to state air pollution control agencies, and selection focused on data elements from Form EIA-767 that are also NAPAP high priority data elements. Information collected via Form EIA-767 but not included in this study includes projected annual fuel consumption, monthly fuel consumption and quality (annual values are included), electricity generation, and cooling system information. All other information from the Form EIA-767 automated data file was included in the data base delivered and includes annual by-product disposition and steam sales, financial information, plant configuration, boiler level annual fuel consumption and quality, boiler air emission standards, boiler design parameters, flue gas particulate collector information, flue gas desulfurization (FGD) unit information, and stack and flue information.

There were two parts to this project. One was to compile a subset of Form EIA-767 data elements (those of most interest to emissions inventory developers) and then to download this information to microcomputer compatible floppy disks. Ten data disks were produced - one for each EPA Region. The second part of this project was to produce microcomputer software that could be used by the states to access the reduced Form EIA-767 data set. This software includes three Form EIA-767 standard reports and one NEDS style summary report.

No attempt was made to change any of the units reported on Form EIA-767. Although changing from Form EIA-767 units to NEDS units was considered, this change was not made so that states with hard copy Form EIA-767 submissions could make direct comparisons with the computer data base.

DATA BASE DESIGN

In the simplest sense, one can take a mainframe data base, download it to a microcomputer, and use microcomputer software to manipulate the data. This paper discusses some of the other important factors associated with creating and using a microcomputer data base. These factors include data quality control, data base management, and software design.

While data base quality assurance and quality control are receiving more emphasis, as evidenced by the extensive QA project planning activities associated with the compilation of the 1985 NAPAP emissions inventory,¹ any data base user is well served by making quality control checks on any data that are to be used in an analysis. This proved to be an important component of the work performed with the Form EIA-767 data file, as the 1982 Form EIA-767 data file was the inaugural computer compilation of data from this new form. Because numerous errors were found in the automated Form EIA-767 file, a rigorous quality control procedure was followed to correct these errors for the high priority data items. These quality control procedures included:

1. Computerized screenings listed in Table I were performed using upper and lower limit values for key data elements to identify possible errors.
2. Consistency checks using multiple data elements were developed and applied where appropriate.
3. Hard copy Form EIA-767 submittals were compared with the automated data file. In most cases, more than one year of Form EIA-767 data were used for this comparison.
4. Flue gas desulfurization (FGD) information from Form EIA-767 was verified with Flue Gas Desulfurization Information Systems (FGDIS) data.⁶

The above QC checks provided a data base with marked improvements in the values for the high priority data elements, which are listed in Table II.

Data base management issues also played an important part in the design of the microcomputer files and in software development. There were two major constraints in downloading the mainframe Form EIA-767 data file to a microcomputer. One was the size of the data base (700 power plants with at least 500 data elements per plant), and the other was the data base structure (linkages among boilers, associated generators, particulate collection devices, SO₂ collection devices, stacks, and flues).

The first step in solving the size problem was to select from the 1982 Form EIA-767 data file the subset of the file most

relevant to state air pollution control agency analyses and the 1985 NAPAP Emissions Inventory effort. Form EIA-767 information eliminated during this step included projected annual fuel consumption, generator information, and cooling system information. Further size problems were solved by partitioning the data files by Federal region and state. Thus, each state received the Form EIA-767 data for all major power plants in its Region. While the separation by region performed for this project was necessary to allow the data to be used on a microcomputer with limited memory, and it served the needs of states interested in their own plants and those of their neighbors, this separation also precluded using the data base for national analyses.

Perhaps the most challenging aspect of this project was structuring the microcomputer data base to provide appropriate linkages among boilers, stacks, and air pollution control equipment. Those familiar with the Form EIA-767 structure should recognize this as being the information provided on the plant configuration page. The task of establishing linkages in this project was made less onerous by not including the generator information in the file. (There can be almost any combination of boilers and generators at a plant.) Nevertheless, the linkage issue was complex, and most of the data base design time was spent on resolving these problems.

The final design of this microcomputer data base resulted in a structure with three linked subfiles, BOILERS, PLANTS, and SOXCTLS. Figure 1 is a schematic of the relationship among the three data bases. BOILERS contains the data elements of most interest to state air pollution control agencies, which include boiler firing type, boiler bottom type, fuel capability, fuel consumption, fuel characteristics, control equipment, and stack parameters. BOILERS also contains linkages to the plant level, particulate collector, FGD unit, and associated stacks and flues.

The PLANTS data base primarily contains information from pages 1, 2, and 4 of the Form EIA 767. This information includes utility and plant names and plant location (page 1), annual by-product disposition and steam sales (page 2), and financial information (page 4).

The SOXCTLS data base contains information on SO_x control equipment (FGD). For units with FGD systems, SOXCTLS provides annual operations data and design parameters.

SOFTWARE DESIGN

Software selection and design for this project focused on three primary issues. The first was to choose a software and data base management system that is universally, or at least widely, available. The dBASE III^R software package was chosen as

the best combination of availability at state agencies and being suited to the job at hand. The second design criterion was to provide standard sets of software that would meet the needs of most state agency users. Finally, the data base management system had to be flexible enough so that users could prepare their own software.

SOFTWARE DESCRIPTION

The software and data base developed and distributed to state air pollution control agencies for the 1985 emissions inventory are designed to be used with microcomputers. The preferable minimum system for accessing the data base and operating the software is an IBM PC/XT with a 10 megabyte hard disk and a dBASE III^R software package. While it is possible to use the software with a floppy disk drive, the software is easier to use once it is loaded onto a hard disk. If a hard disk is available, the floppy disks should be copied to a hard disk where the dBASE III^R software is located to prepare to run the software.

To facilitate comparison of DOE with 1985 NEDS data, software was developed to present the DOE data in a NEDS style summary report as well as three standard DOE reports. As the software is currently written, the NEDS style summary report (as shown in Table III) is designed to display labeled data on a computer screen. The user can scroll through this information to display information for the plants or boilers of interest, but the system is not currently designed to print this information unless directed to by the user. Conversely, the software for the three DOE summary reports is designed to print this information, but not to display it on the computer screen, because the summary reports are only a page or two in length.

While the reports described above are designed to meet the needs of most users, some users may wish to prepare different reports. Those who are proficient in dBASE III^R programming can use the data provided and can write programs to use the data in any manner they choose.

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Table I. Criteria used to screen for possibly erroneous data elements.

Data Element	Limits (English Units)	Limits (Metric Equivalents)
Heating Value: ^{2,3}		
Coal	12-29 x 10 ⁶ Btu/ton	14-34 MJ/kg
Petroleum	118-173 x 10 ⁶ Btu/10 ³ gal	33-48 MJ/liter
Natural Gas	950-1,150 x 10 ⁶ Btu/10 ⁶ cu ft	35-43 MJ/cu m
Percent Ash: ^{2,3}		
Coal	4-20%	
Petroleum	0.00-0.5%	
Percent Sulfur: ^{2,3}		
Coal	0.3-5.4%	
Petroleum	0.01-4%	
Fuel Consumption	0.1 ≤ QA ^a ≤ 1.0	
Stack Height (H) ⁴	100 ft < H < 1,000 ft	30.48 m ≤ H ≤ 304.8 m
Stack Height/Diameter Ratio (H/D) ⁴	10 ≤ H/D ≤ 60	
Stack Temperature (T) ⁵	if no scrubber T > 100° F if scrubber T < 250° F	if no scrubber T > 38° C if scrubber T < 121° C
Stack Flow Rate (Q) ^{4,5}	173 < Q ^b < 260 scfm/10 ⁶ Btu/hr	16.7 < Q ^b < 25.1 cu m per min/MW
Stack Velocity (V) ^{4,5}	600 ft/min ≤ V ^c ≤ 8,000 ft/min	183 m/sec ≤ V ^c ≤ 2,438 m/sec

(a) QA = [(coal consumption x heating value) + (oil consumption x heating value) + (natural gas consumption x heating value)] / [plant boiler design capacity x 8760 hours]

(b) Q = stack flow rate / boiler design capacity

(c) V = stack flow rate / stack cross-sectional area at top of flue

Table II. NEDS/NAPAP 1985 Emissions Inventory high priority data elements.

1. Year of Record
2. Universal Transverse Mercator (UTM) Zone, UTM Coordinates
3. Stack Data
4. Boiler Design Capacity
5. Control Equipment and Control Efficiency
6. Percent Annual Throughput
7. Normal Operating Schedule
8. Emissions Estimates and Estimation Method
9. Source Classification Code
10. Annual Fuel, Process, Solid Waste Operating Rate
11. Fuel Sulfur Content
12. Fuel Ash Content

Table III. Example of NEDS summary report.

Plant Information for XXXXXXXX

1. Company Name:
2. State: Code:
Nearest Post Office:

Boiler Information

1. Boiler Identification Number:
2. Boiler Design: a. Design capacity:
 b. Firing type:
 c. Bottom type:
3. Fuel Consumption and Quality:

	Coal	Petroleum	Natural Gas
a. Consumption			
b. Max oper rate/hr			
c. Heating value (Btu/unit)			
d. Percent ash			
e. Percent sulfur			

4. Stack Data: Coordinates:

	Latitude:	Longitude:
Zone:	UTM-Northing (km):	UTM-Easting:
Height (ft):	Area (sq ft):	Temperature (°F):
5. Control Equipment:

a. Particulates: Type:	Estimated Efficiency (%):
b. Sulfur dioxide: Type:	Estimated Efficiency (%):
c. NO _x control equipment-low NO _x burners (y-n):	
6. Boiler vents to the same stack as other boilers at this plant:

87-58.4

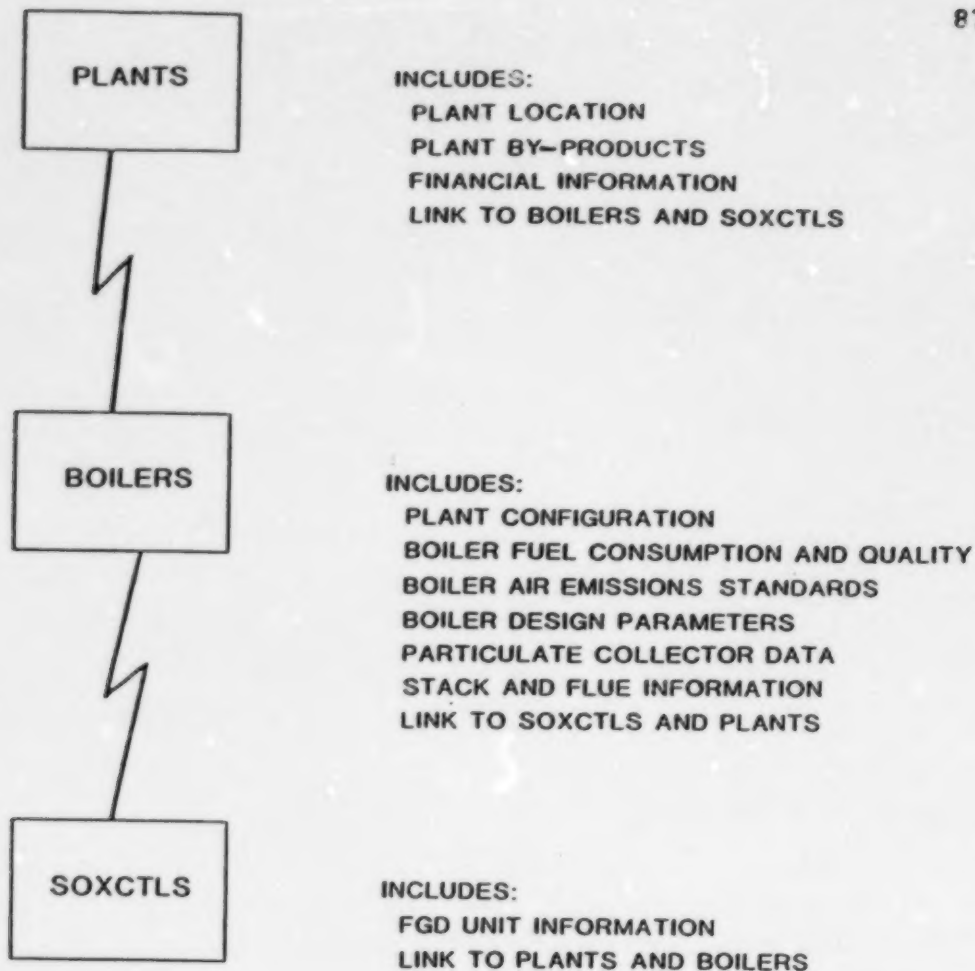


Figure 1. Relationships among PLANTS, BOILERS, SOXCTLS data bases

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